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GB 2210538 A GB 2046059 A GB 1544774 A
EP 0337703 A US 4454488 A

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(54) **Transponder with code identification circuit having a surface acoustic wave device filter**

(57) An identification circuit suitable for use as an identification tag for airport baggage includes a surface acoustic wave device 20 which functions as narrow bandwidth filter (eg. 10 kHz) for RF signals received at an antenna 10. A semiconductor integrated circuit 30 recognises an identification code which modulates the filtered signals and generates a reply code in response. The SAW device 20 provides substantial immunity of the circuit to RF interference. A coded RF signal is transmitted from antenna 10 by causing the reply code signal to modulate an RF resonance signal of the SAW device 20, which is either operated in an active mode being caused to oscillate at its resonant frequency, or for low power applications the device 20 may operate in a passive mode in which it acts as a filter to select harmonies of the reply code signal.

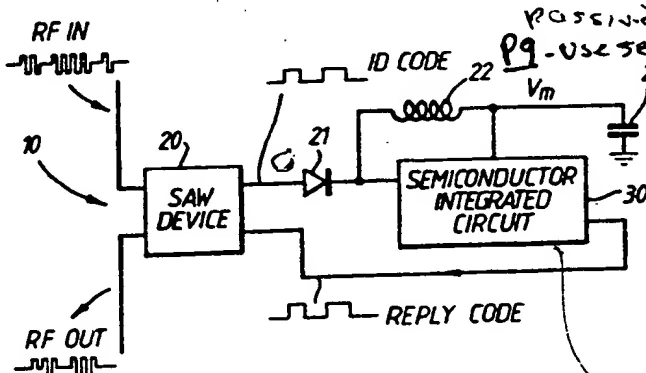
active/passive modes

AM - PS

active - P8 for high power (battery)

passive - ~~self~~ power

P9 - use separate p.s. when signal strength l



IC

Fig. 1.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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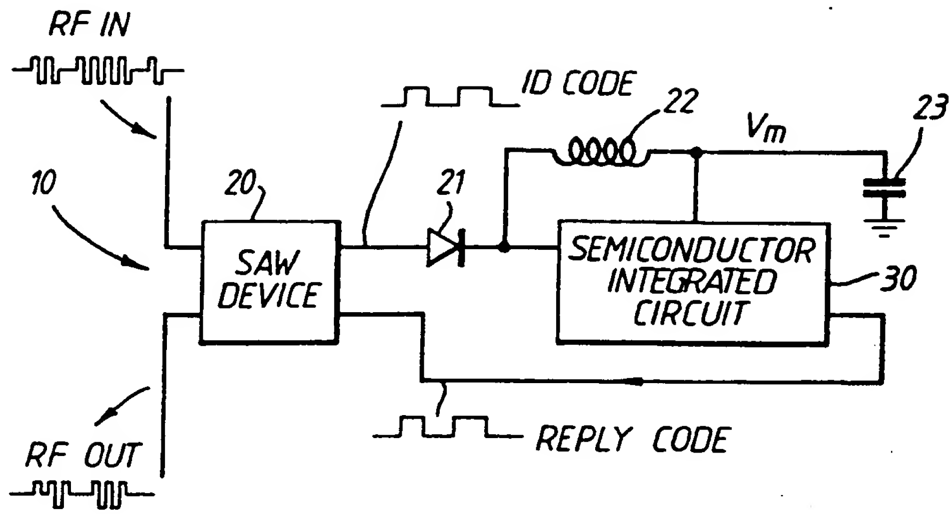
RF IN
ID CODE
22
Vm
23
10
20
21
SAW DEVICE
SEMICONDUCTOR INTEGRATED CIRCUIT
30
REPLY CODE
RF OUT

Fig. 1.

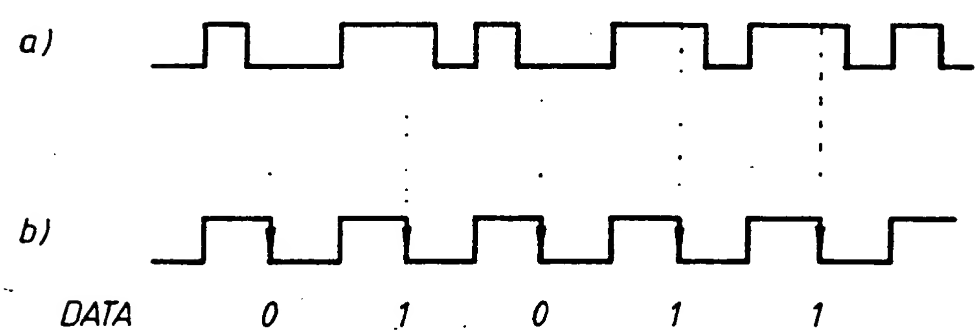
a)
b)
DATA
0
1
0
1
1

Fig. 3.

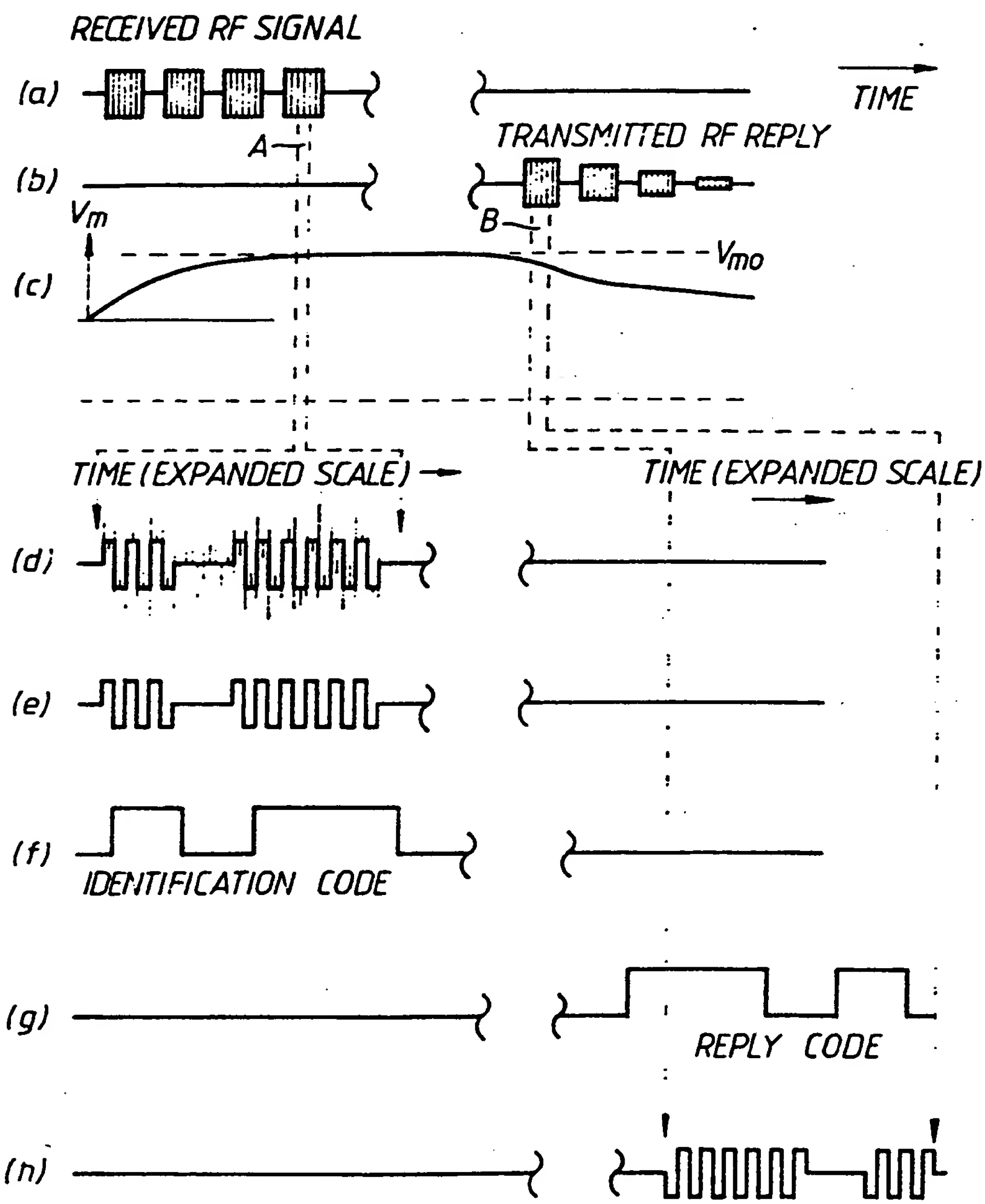
RECEIVED RF SIGNAL
(a)
TIME
A
TRANSMITTED RF REPLY
(b)
B
Vm
Vmo
(c)
TIME (EXPANDED SCALE)
TIME (EXPANDED SCALE)
(d)
(e)
(f)
IDENTIFICATION CODE
(g)
REPLY CODE
(h)

Fig. 2.

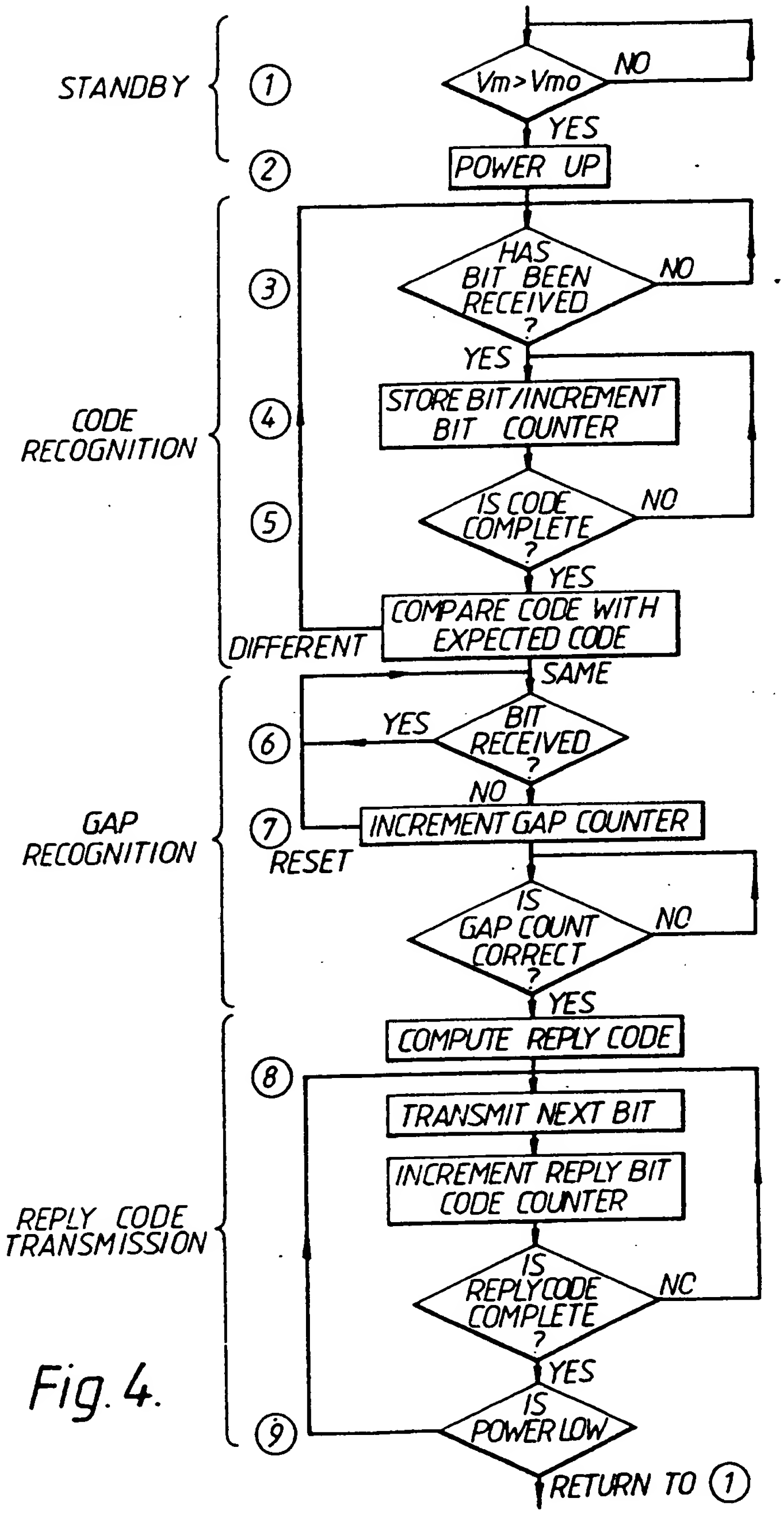
STANDBY
CODE RECOGNITION
GAP RECOGNITION
REPLY CODE TRANSMISSION
1
Vm>Vmo
NO
YES
2
POWER UP
3
HAS BIT BEEN RECEIVED ?
NO
YES
4
STORE BIT/INCREMENT BIT COUNTER
5
IS CODE COMPLETE ?
NO
YES
COMPARE CODE WITH EXPECTED CODE
DIFFERENT
SAME
6
YES
BIT RECEIVED ?
NO
7
INCREMENT GAP COUNTER
RESET
IS GAP COUNT CORRECT ?
NO
YES
COMPUTE REPLY CODE
8
TRANSMIT NEXT BIT
INCREMENT REPLY BIT CODE COUNTER
IS REPLY CODE COMPLETE ?
NO
YES
9
IS POWER LOW
RETURN TO 1

Fig. 4.

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IDENTIFICATION CIRCUIT

This invention relates to an identification circuit and particularly to electronic identification tags. The invention has especial, though not exclusive, application to electronic identification tags for airport baggage.

A known electronic identification tag comprises a tapped surface acoustic wave (SAW) device which is used as a code generator. In effect, the SAW device operates as a transponder capable of generating an identification code in response to a radio frequency (RF) pulse received via an antenna from a remote transmitter.

The SAW device responds to the received pulse by creating echo pulses at predetermined time intervals which define the identification code for the tag. These echo pulses are transmitted by the antenna to a remote receiver programmed to recognise the identification code. In order to produce an economically viable product, manufacturing considerations dictate that the SAW device should operate at high frequency, within a relatively wide frequency band (typically 10 MHz). Accordingly, the SAW devices used hitherto tend to be susceptible to RF interference and have problems of frequency allocation due to the large percentage bandwidth.

Semiconductor devices have also been used in the development of identification tags. However, these devices are unsatisfactory in that they are not able to transmit signals at convenient intermediate frequencies.

According to one aspect of the present invention, there is provided an identification circuit comprising,
means for receiving radio frequency (RF) signals,
a surface acoustic wave device for selecting received RF signals within a narrow, predetermined RF bandwidth,
a semiconductor circuit for recognising a predetermined identification code modulating the selected RF signals and for generating an encoded output signal in response to recognition of the predetermined identification code,
and means for transmitting the encoded output signal as a modulation of an RF signal.

In contrast to known identification circuits, the surface acoustic wave device functions as a filter, enabling the identification circuit to operate within a relatively narrow RF bandwidth (typically 10 kHz). Therefore, the identification circuit offers substantial immunity to RF interference signals.

The encoded output signal, generated by the semiconductor

circuit, may be identical to, or differ from, the predetermined identification code recognised by the semiconductor circuit.

The encoded output signal may modulate an RF resonance signal (i.e. an oscillation) of the surface acoustic wave device for transmission by the transmission means.

The surface acoustic wave device may select harmonics from the encoded output signal for transmission by the transmission means.

The identification circuit may include means for deriving power for the semiconductor circuit from received RF signals, and the power may be derived from RF signals input to, or output from, the surface acoustic wave device.

According to another aspect of the invention, there is provided an identification tag (for airport baggage, for example) comprising an identification circuit in accordance with the first aspect of the invention.

An identification circuit embodying the invention is now described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 shows the identification circuit in block schematic form;

Figures 2a to 2g show the waveforms of signals at different points in the identification circuit of Figure 1;

Figures 3a and 3b show respectively the identification code and clock pulses derived from the identification code; and

Figure 4 is a flow diagram illustrating an algorithm used to control a semiconductor integrated circuit in the identification circuit of Figure 1.

Referring now to Figure 1, the identification tag comprises three main components, namely an antenna 10 for the reception and transmission of RF signals, a surface acoustic wave (SAW) device 20 and a semiconductor integrated circuit 30.

The RF signals, to which the identification tag is arranged to respond, are generated by a remote transmitter/receiver unit (not shown) and incorporate a predetermined identification code (to be detected) which modulates the amplitude of an RF carrier signal.

The SAW device 20 functions as a low insertion loss, narrow bandwidth filter for the received RF signals. Typically, the filter has an insertion loss in the range 2-3 dB.

In operation, SAW device 20 is selective of RF signals within typically a 10 kHz bandwidth, centred on 200 MHz, and the selected signals are supplied to circuit 30 for processing. By this means, the identification tag has substantial immunity to interference from RF signals having frequencies outside the afore-mentioned bandwidth. Moreover, it is possible to allocate any number up to one thousand more frequency channels than is possible for the known tapped surface acoustic wave devices.

As will be described in greater detail hereinafter, the semiconductor integrated circuit 30 is so programmed as to recognise the predetermined identification code, which modulates the amplitude of the received RF carrier signal, and, in response, to generate a suitably encoded reply which may be the same as, or differ from, the identification code. The encoded reply, generated by circuit 30, modulates the amplitude of an RF output signal which is transmitted by antenna 10 via the SAW device 20.

Figure 2(a) illustrates the waveform of pulsed RF signals as received at antenna 10, and Figure 2(b) illustrates the waveform of corresponding RF signals transmitted by antenna 10 in reply to the received signals upon recognition of the predetermined identification code.

As will be clear from Figure 2(a), the pulses sent from the remote transmitter/receiver unit are subject to interruption (INT) in order to allow a reply to be transmitted.

Figure 2(d) represents, an an enlarged time scale, a section (referenced A) from one of the received RF pulses, and shows, in detail, a corresponding section of the predetermined identification code which modulates the amplitude of the received signals.

As will be clear from Figure 2(d), the RF signals received at the input to the SAW device 20 contain RF inteference and noise signals.

Figure 2(e) shows the same section (A) of the RF pulse produced at the output from device 20, following removal therefrom of the unwanted interference and noise signals.

The filtered RF signals are supplied to the semiconductor integrated circuit 30 which is programmed to recognise

the identification code. Figure 2(f) shows a part of the identification code corresponding to the said section A of the received signals, shown in Figure 2(d).

In this embodiment, the identification code is defined in terms of a pulse-width modulation of the received RF signals, although it would alternatively be possible to employ either phase-coded modulation or amplitude modulation.

Figure 3(a) shows, by way of example only, the complete pulse-width modulated identification code, represented by the binary sequence 0,1,0,1,1, and Figure 3(b) shows corresponding clock pulses derived from that code.

The semiconductor integrated circuit 30 operates on the clock pulses to generate a reply code, of which a section (referenced B) is illustrated in Figure 2(g).

In this embodiment, the reply code is exactly the same as the received identification code, though this need not necessarily be so. Indeed, to give added security against possible "mimic" devices, it maybe desirable to arrange that the reply code and the identification code are not the same.

The reply code generated in this manner is routed to the SAW device 20. In response, device 20 generates an RF signal which is modulated by the reply code, as shown in Figure 2(h), and then transmitted by antenna 10.

To that end, the SAW device 20 may be deployed in an active mode or, alternatively, in a passive mode.

For high power applications, it may be necessary to provide an RF gain stage, such as a transistor, supplied by a suitable power source - a battery, for example.

In the active mode, the device is caused to oscillate at its resonant frequency, and the amplitude of the resulting resonance signals is modulated in accordance with the reply code.

For low power applications, involving transmission over a relatively short range, the SAW device 20 is subjected to impulses produced by the rising and falling edges of the reply code. In this way, the device 20 is caused to oscillate at the resonant frequency and thereby produces the required pulse-width modulated RF signal for transmission by antenna 10.

In the passive mode of operation, the SAW device 20

functions as a filter whereby to select high frequency, RF harmonics from the baseband, rectangular wave reply code produced by the semiconductor integrated circuit 30.

In the illustrated embodiment, power for circuit 30 is derived from the received RF signals. To that end, the received signals either at the input to, or the output from, the SAW device 20 are supplied via a diode 21 and a resistor 22 to a capacitor 23 which stores the mean voltage V_m of the received signals.

When, as illustrated in Figure 2(c), the stored voltage exceeds a threshold valve V_{mo}, the semiconductor integrated circuit 30 receives sufficient power to commence operation enabling the predetermined identification code to be recognised and a reply code to be generated in response.

This form of self-powered integrated circuit can be used when the strength of the received signals is relatively high, in short range applications, for example. However, when the signal strength is low, a separate power supply (e.g. a battery) may be needed.

The flow diagram, shown in Figure 4, represents an algorithm used to control circuit 30.

Initially, the circuit is in a STANDBY MODE and compares the afore-mentioned voltage level V_m, derived from the received RF signals, with the threshold voltage level V_{mo} (stage 1). If V_m exceeds V_{mo}, the circuit is powered up (stage 2) and starts to interrogate the received signals in order to identify the first bit of the identification code (stage 3). If this bit is identified by circuit 30, its value is stored in a memory and a bit counter is incremented (stage 4). The circuit then proceeds to identify succeeding bits of the identification code, incrementing the bit counter each time a new bit is identified.

The circuit evaluates whether or not the bit counter holds the correct number of bits for the expected identification code (stage 5) and, if it does, the detected code is compared with the predetermined identification code stored in the circuit's memory (stage 6). Upon recognition of the code, the circuit seeks to identify the afore-mentioned interruption (INT) in the received signals in order that it may initiate transmission of the reply code. To that end, the circuit increments a "gap" counter each time a bit is absent from the received signals (stage 7) and when the value held in the gap counter indicates that an interruption has been detected, the circuit transmits the reply code (stage

8). In this embodiment, the reply code is derived from the predetermined identification code. As each bit of the reply code is transmitted, a reply code bit counter is incremented until the entire code has been transmitted, and provided the voltage level V_m has fallen below the threshold level V_{mo}, the circuit 30 reverts to the STANDBY MODE (stage 9).

It will be understood that this algorithm is given, by way of example only, and other schemes, designed to achieve the same end, could alternatively be used.

It will be further understood that the semiconductor, integrated circuit 30 may be re-programmable whereby to change the predetermined indentification code as desired. Moreover, the narrow band response of the SAW device 20 makes it possible for different identification circuits to operate in different frequency ranges, the SAW device enabling many different identification devices to operate simultaneously with a single remote transmitter/receiver interrogating them. Thus, the transmitter/receiver may poll the different possible frequencies allocated to different respective identification tag devices (in time multiplexed fashion) or alternatively may operate on all the possible frequencies simultaneously (in frequency multiplexed fashion).

The identification circuit, thus described, has the advantage that it can process relatively long identification codes and yet operates within a relatively narrow bandwidth, providing substantial immunity to RF interference signals. Moreover, in some applications, the identification circuit does not need a separate power supply, but may derive power instead from the received RF signals.

CLAIMS

1. An identification circuit comprising,
means for receiving radio frequency (RF) signals,
a surface acoustic wave device for selecting received RF signals within a narrow, predetermined RF bandwidth,
a semiconductor circuit for recognising a predetermined identification code modulating the selected RF signals and for generating an encoded output signal in response to recognition of the predetermined identification code,
and means for transmitting the encoded output signal as a modulation of an RF signal.

2. An identification circuit as claimed in claim 1, wherein the encoded output signal, generated by the semiconductor circuit, is identical to the predetermined identification code identified by the semiconductor circuit.

3. An identification circuit as claimed in claim 1 or claim 2, wherein the encoded output signal, generated by the semiconductor circuit, differs from the predetermined identification code identified by the semiconductor circuit.

4. An identification circuit as claimed in any one of

claims 1 to 3, wherein the encoded output signal is arranged to modulate an RF resonance signal of the surface acoustic wave device for transmission by the transmission means.

5. An identification circuit as claimed in any one of claims 1 to 3, wherein the surface acoustic wave device selects harmonics from the encoded output signal for transmission by the transmission means.

6. An identification circuit as claimed in any one of claims 1 to 5, including means for deriving power for the semiconductor circuit from received RF signals.

7. An identification circuit as claimed in claim 6, wherein the power is derived from RF signals input to, or output from, the surface acoustic wave device.

8. An identification circuit as claimed in any one of claims 1 to 7, wherein the semiconductor circuit is so arranged that the predetermined identification code and the encoded output signal can be re-programmed.

9. An identification tag comprising the identification circuit as claimed in any one of claims 1 to 8.

10. An identification tag as claimed in claim 9 suitable for use as an identification tag for airport baggage.

11. An identification circuit substantially as herein described with reference to the accompanying drawings.

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